18. Explain what is meant by Schrodinger picture? Discuss the Schrodinger picture for describing the dynamical behavior of a system and obtain the equation of motion for a state function and an operator.

19. Apply the perturbation theory to evaluate the first order energy shift in the ground state of a linear harmonic oscillator by a small perturbing potential Cx^4 in the Hamiltonian.

20. Find the eigen value spectrum of J^2, J_z.

APRIL/MAY 2025

23PPH22 — QUANTUM MECHANICS — I

Time : Three hours Maximum : 75 marks

SECTION A — (10 × 2 = 20 marks)

Answer ALL questions.

1. Write at least two basic postulates of quantum mechanics.

2. State Heisenberg's uncertainties relation.

3. How will you construct a square well potential?

4. What do you mean by rigid rotator?

5. What is interaction representation?

6. What do you mean by unitary transformations?

7. State start effect.

8. What is meant by variation methods?

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9. What are Clebsch-Gordan coefficients?

10. State Pauli's exclusion principle.

SECTION B — (5 × 5 = 25 marks)

Answer ALL questions.

11. (a) Prove that the Eigen value of a Hermitian operators is real, and any two eigen functions of a Hermitian operator that belong to different eigen values are orthogonal.

Or

(b) State and prove Ehrenfest's Theorem.

12. (a) Show that the energy and wave function of a particle in a square well of finite depth V_0 reduces to the energy and wave function of a square well with rigid walls in the limit $V_0 \to \alpha$.

Or

(b) The energy of a linear harmonic oscillator in third excited state is 0.1 eV. Find the frequency of vibration.

13. (a) Represent the momentum in terms of Dirac Notation.

Or

(b) Explain the effect of parity operator on the observables r, p and L.

14. (a) Derive the expression for the energy of the ground state of the helium atom by variation method.

Or

(b) Obtain the energy levels of harmonic oscillator by WKB method.

15. (a) Find :

(i) $[J_+, J_-]$ (ii) $[J_x, J_y]$

Or

(b) Distinguish between symmetry and anti symmetry wave function.

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SECTION C — (3 × 10 = 30 marks)

Answer any THREE questions.

16. Derive both the time independent and time dependent Schrodinger equations for a non-relativistic particle.

17. Construct a radial wave equation for hydrogen atom and derive the energy Eigen values and Eigen functions.